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IN BIODIVERSITY CONSERVATION

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Beyond Economic Efficiency in Biodiversity Conservation

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Abstract

This paper aims at explaining the importance of the democracy stance as compared to the efficiency stance in order to deal with complexity in biodiversity conservation. While the efficiency stance refers to the realm of relatively simple systems, individual rationality, and instrumental values, the complexity stance transcends these boundaries into the realm of complex systems, social rationality and intrinsic values. We argue that the task of biodiversity conservation is impossible to achieve in economically efficient ways, because (a) it is impossible to come to a (fully informed) complete account of all values, not only because it is costly but also because (b) moral values are involved which (by their nature) exclude themselves from being accounted for, and (c) biodiversity conservation can be regarded as an end in itself instead of only a means towards an end. The point we raise is, that in order to cope with biodiversity conservation we need to apply valuation methods which are from the complexity stance, take better account of intrinsic values and feelings, as well as consider social rationality. Economic valuation methods are themselves 'value articulating institutions' and as biodiversity conservation confronts us with the complexity of social-ecological systems, the choice of the 'value articulating institutions' needs to consider their ability to capture instrumental and intrinsic values of biodiversity. We demonstrate a method, based on cybernetics, which is able to take into account the issues raised.

Key words: Biodiversity conservation, efficiency, complexity, values, institutions
JEL-Codes: B52, Q51, Q57

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1 Introduction

Many attempts have been made to explain the worldwide decline of biodiversity. Economists and ecologist have approached the question from different angles. They have assessed, monitored, and valued biodiversity; they have discovered ecological dynamics and economic, institutional, and political failures as reasons for biodiversity decline and have met in creating new institutions for protecting biodiversity. But the closer look one takes at the diversity of life and the more detailed analysis is pursued, the less we know about biodiversity as part of the entire socio-ecological system or "web of life" (Capra 1996). Logic does not lead us from an increasing amount of facts [about biodiversity] to norms or values of how we should live [or conserve biodiversity] (ibid: 12). "Even if ecologists knew more about how particular ecosystems function, and knew how those functions would change with human modification, economists would not know what to do with this information." (Roughgarden 1995: 150). And while ecologists are still afraid that economists could underestimate the value of biodiversity (ibid), economists continue to ingeniously calculate impressive monetary estimates for biodiversity values (Costanza et al. 1998; Hein and Gatzweiler 2006), hoping that policy makers are impressed by these figures and take biodiversity conservation policies more serious. Despite these efforts politicians and leading decision-makers generally disregard valuation studies with the effect that to date the majority of resource allocation decisions in most countries have not been made on the basis of resource valuation (Byron and Bennet 1999). Others again think that with regards to biodiversity "we should be more in awe than in arithmetic" (O'Riordan and Stoll-Kleemann 2002: 3).

In this difficult and contradictive terrain, characterized by knowledge gaps and claims, it is not easy to keep in sight what actually matters, whose values and views count and how to take them into account. One widely held argument, especially among economists is that whatever strategy we choose to conserve biodiversity, it should be done efficiently, so that scarce resources are not wasted. The consistency and clarity of logic is appealing and nicely presented in Baxter's (1974) book entitled "People or Penguins – The Case for Optimal Pollution". Baxter addressed the question in his "case for optimal pollution" by arguing that in dealing with a problem like pollution it is important to know what one is attempting to accomplish. According to Baxter, biodiversity conservation is not an end in itself, rather it is a means to achieve 'a more general community goal', such as that "every person should be free to do whatever he wishes in contexts where his actions do not interfere with the interests of other human beings" (ibid). We could define a similar goal by saying that conservation of biodiversity is a means to contribute to human wealth. Baxter defines this ’higher community goal’ in order to avoid the ’why’-question: Why should we conserve biodiversity and how much biodiversity should we conserve? Baxter (1974) avoids these questions by defining a higher goal which, according to him, make the ’why’ question “no longer seem admissible” and by defining criteria which he uses to frame “solutions to problems of human organization”. These criteria are “oriented to people, not penguins”, which means that preserving penguins (or biodiversity) is simply irrelevant if it is not for the sake of people, who enjoy seeing them “walking about rocks”. Penguins walking about rocks is used by Baxter as a metaphor to illustrate that people regard nature as useful and important. Nature, in his view, will be preserved “because and to the degree that humans do depend on it”. According to Baxter, carrying out biodiversity conservation in its own right (as an end in itself) would be irrational and not efficient because the reason for conservation can not be: ”for the sake of conservation”. Efficiency is defined as getting the most out of the resources employed to achieve a certain goal and biodiversity conservation is the means to achieve the goal of well-being, in terms of happiness, richness, or pleasure (e.g., seeing penguins walking about rocks).

The economic problem of biodiversity loss describes the fact that most efforts to conserve and sustainably use biodiversity are not economically rational. Most land use decisions which lead to biodiversity loss only consider private costs and benefits, whereas economically rational decisions would also consider social costs and benefits. The consequence of social costs being higher than private costs are external costs. The private land user who, e.g., converts forest into agricultural land does not feel and consider the negative consequences of his actions for the larger society. Market and policy failures are identified as causes of biodiversity loss when, e.g., there is no market which could translate the willingness to pay for biodiversity into actual income for farmers, or when a subsidy further reduces the private costs of converting a forest and thereby increases the difference between private and social costs of conversion. Valuing ecological goods and services, creating new markets (e.g., ecotourism), regulating markets by trade restrictions (e.g., environmental standards), or international transfers (e.g., debt-for-nature swaps) are examples for measures to internalize external costs and thereby reduce or even avoid market and policy failure (Marggraf 2005: 3). Therefore, from an environmental economists’ perspective, in a world where policy and market failure would not occur, biodiversity would not be lost if people do not want to loose it. Loosing biodiversity would be optimal, however, if people do not mind or even prefer to loose it. It is also a fact, however, that all people never consider exactly the same values, so that for some part of society the loss (as well as the conservation) of some part of biodiversity would always be sub-optimal. The problem of not being able to achieve efficiency is not only caused by the existence of value plurality but also by the fact that certain categories of values are not captured by the methods typically applied to account for values in economics. We will address that issue again in the section on values (section 5).

In the following, we will portray Baxter's arguments as the *economic efficiency stance*, as opposed to the *complexity or democracy stance*. We will examine both stances with regard to the task of biodiversity conservation and place criteria which define them into a three-dimensional space (Figure 1). The criteria are (adapted from those defined by Arild Vatn (2005: 419)): 1) rationality, 2) complexity, and 3) type of social choice. Institutional diversity can be regarded as a forth dimension resulting from the other three. The more complex systems get, the more difficult it is to organize them with a single set of institutions and governance structures (Gatzweiler 2005a, 2006); thus, institutional diversity would increase with increasing levels of the three criteria. Each criteria is a fuzzy concept and therefore expressed in different degrees between the two extremes of totally existent (1) or not (0).

What we are dealing with when addressing the challenge of biodiversity conservation are complex socio-ecological systems, composed of multiple system components with multiple functions and interactions. Understanding the behaviour of these systems involves a trade-off between vagueness and precision, and between isolated relationships of few system components and holistic system behaviour. With increasing precision about single system components and their causal relationships, knowledge of overall system behaviour becomes increasingly vague[1]. Regarding the feature of fuzziness, Magurran (1988) says that the more biodiversity is looked at, the less clearly defined it appears to be and viewing it from different angles can lead to different perceptions of what is actually involved. Zadeh states the principle of incompatibility in fuzzy set theory, which says that with increasing system complexity the ability to make precise statements diminishes until a threshold is reached where precision and significance become mutually exclusive. (Zadeh 1987, 1975a,b; Weiling and Lee 1995). The 'value of the world's ecosystem services' (Costanza et al. 1998) is a good example: the authors calculate a number on the grounds of assumptions of the efficiency

[1] What fuzzy logic tells us is that, in order to understand complexity, it is necessary to understand not only the separate parts themselves but their relationships which tell us about the functioning of the complex entity. Imprecise but highly relevant (hence, valuable) economic predictions determined by common sense are often expressed by experienced economists in linguistic terms; e.g., "the price of coffee is not likely to increase substantially in the near future" (Klir and Yuan 1995). We have applied the same principle in our attempt to initiate the development of sustainable use and conservation concepts for the coffee forests in Southwest-Ethiopia.

stance, which, taken their own discussion into account, is meaningless, but better than no number at all.

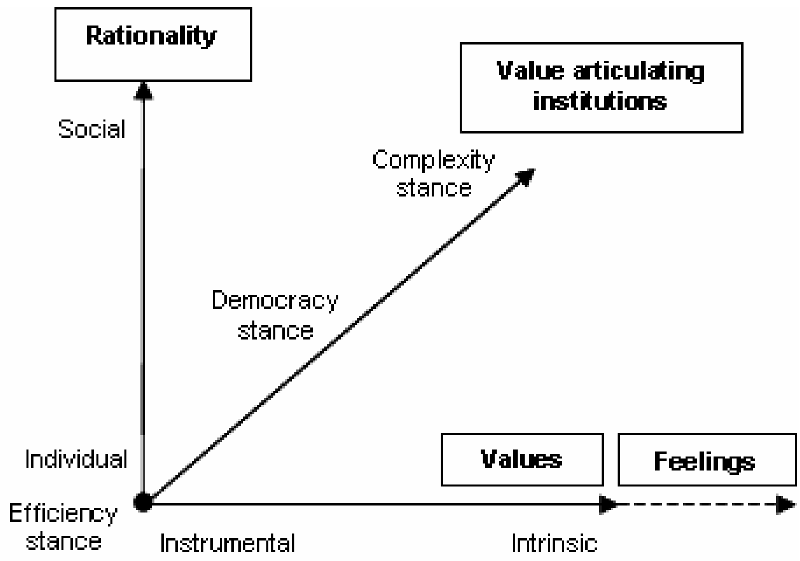

Figure 1: Criteria Defining Different Stances for Biodiversity Conservation

Source: Based on Vatn (2005)

In this paper, we argue that beyond efficiency, it is important to understand complex socio-ecological system's behaviour in order to conserve biodiversity; and in order to do so vague knowledge about single isolated system relationships can (or even needs to) be tolerated. Biodiversity conservation is a challenging organizational task which involves: 1) the diversity of ecological systems and their components which have multiple attributes, e.g., with regards to their nature (private or public goods), and 2) the diversity of social systems, i.e. multiple stakeholders and their behavior, interactions, and rules. Coping with complexity in biodiversity conservation not only requires an understanding of the nature of the good to be conserved but also of how people perceive it and organize to deal with the task of conservation. The argument we bring forth is, that in order to cope with this challenge we need to 1) apply valuation methods which are from the complexity stance, 2) take better account of intrinsic values and feelings, as well as 3) consider social rationality. Viewing the task of biodiversity conservation from a systemic perspective, like we do in this paper, may contribute more to awareness building instead of providing simple answers and quick fixes based on assumptions from the efficiency stance for decision-makers confronted with the task of biodiversity conservation. We think that such decision-support in biodiversity conservation is potentially of little value because it neglects the complexity of the task, which is defined by social rationality and social processes of value construction, including intrinsic values, and feeling.

The case we refer to in order to demonstrate how to provide decision-support in complex problem settings is the loss of coffee genetic resources in the montane rainforests of Southwest-Ethiopia. The world's *Coffea arabica* stocks originate from wild populations growing in these rainforests in Ethiopia, which are their natural habitat. Deforestation heavily endangers their existence. A project funded by the German Government, 'Conservation and Use of Wild Populations of *Coffea arabica* in the montane Rainforests of Ethiopia' (CoCE)[2] has set out to develop concepts for their sustainable use and conservation.

The paper is organized as follows: First, we present the mainstream economic arguments which explain biodiversity loss and suggest that higher efficiency in the conservation of biodiversity would actually lead to conserving those amounts of biodiversity which makes people better off; be the biodiversity lower or higher than before. We contrast the relatively simple world of efficiency by introducing aspects of complexity with respect to biological and institutional diversity, social rationality, intrinsic values, feelings, and social processes as value articulating institutions. Introducing that kind of complexity raises the question of how helpful efficiency based decision-support for policy makers is and if it ignores values and social processes at an institutional level which has a lasting grip on the way a society conducts itself.

2 From Simple to Complex: Types of Biological and Institutional Diversity

Biodiversity can be defined as differences among biological entities and as such it is not only a resource but also a condition (Wood 2000: 35; Denich et al. 2005: 8). Such differences can be, e.g., structural, functional, or behavioral. As a resource biodiversity can be governed in terms of efficiency. That is a strict anthropocentric view and we can attach anthropocentric and instrumental values to biodiversity as a resource. Seen as an environmental condition or state, biodiversity is as a precondition for the maintenance of biological resources and a necessary precondition for adaptive evolution and self-regulatory mechanisms of ecosystems (Wood 2000: 49). This conception of biodiversity "transcends the problems inherent in the allocation of scarce resources among competing interests." (Wood 2000: 57). Wood distinguishes biodiversity from the diversity of biological resources. The former is a

[2] The project is carried out by BioTEAM (Biosphärenforschung - InTEgrative und Anwendungsorientierte Modellprojekte) - Program of the Federal Ministry of Education and Research (BMBF), Germany. www.coffee.uni-bonn.de.

necessary condition for the continuing flow of biological resources and therefore "the conservation of biodiversity can be seen as a means for maintaining values that are universal and largely independent of the competition over scarce biological resources. While biodiversity as a resource refers to single biological entities with distinct instrumental values for humans, biodiversity as a condition or state refers to the diversity of initial conditions which are a precondition for the evolving, complex, adaptive, and unpredictable nature of ecosystems.

Ellis (2005a,b) holds that complexity has no clear theoretical definition but that complex structures consist of hierarchically ordered "modules" which are more or less independent and whose structures can be studied in their own right, e.g., cells and bodies or individuals and groups of resource users "who are linked to each other and to multiple resources that occur across multiple scales through multi-level governance arrangements" (Janssen et al. 2003). Berkes et al. (2003: 6) further state that "problems and solutions of [biodiversity] conservation at the generic level are considerably different from those at the species level or landscape level. Different groups of conservationists focus on different levels; they may use different research approaches and may recommend different policies. Biodiversity can be considered at different levels of scale. However, because there are strong feedbacks among the genetic, species and landscape levels, there is coupling between different levels, and the system should be analyzed simultaneously across scale." Complex systems are not only defined by structure and scale but also by change. Causal relation within systems can change and the relative intensity of these relations can also change. Common and Stagl (2005) describe complex systems as systems in which causal relations between components change, and which are able to adapt and evolve. The change of species distribution and composition as response to changing from industrial to organic agriculture is an example. Complexity and change in ecosystems are largely a result of the initial differences among biological entities (biodiversity) of the system; yet another reason to not merely view biodiversity as a resource.

The efficiency stance neglects complexity to a large extent. Although Baxter (1974) recognizes that some components of the ecosystem (here, Penguins) may be important to humans, as soon as this relationship is not evident or known it becomes irrelevant. Given that human actors have imperfect knowledge about complex social- and ecological systems, uncertainty prevails. Different possible outcomes of their actions may be known but probabilities can not be assigned to them (Common and Stagl 2005: 380). Lugo (1995), for example, suggests that trying to quantify sustainable harvest levels in tropical forests rarely leads to ecosystem sustainability. This is because the entire socio-ecological system is in a state of constant change. Change and disequilibrium, rather than equilibrium, are the dominant system conditions (Berkes et al. 2003: 7) we are dealing with in biodiversity conservation.

Complex systems are also defined by diversity. In general, ecologists take the view that biological diversity promotes the resilience of systems (Common and Stagl 2005: 55). Different groups of species take over different functions in a system and therefore the persistence of ecosystem functions over time (i.e. the resilience of ecosystem functions) depends on the diversity of species within functional groups (Gunderson and Holling 2002). Gunderson and Holling (2002: 407) distinguish two forms of diversity within functional groups: *functional compensation* and *functional reinforcement*. Functional compensation occurs when one species goes extinct and is replaced by another species with similar functions but which is less sensitive to environmental change or disturbance. Such compensation occurs at the same or within a narrow range of scales. Functional reinforcement occurs when species perform similar functions across very different scales. Small birds, for example, that feed on larvae help to regulate insect infestation; and when the larvae becomes a worm, different large birds perform the same task, yet at a different scale. The two types of diversity effects can be described as follows: 1) Similar species at similar scales with similar functions but different sensitivities to disturbance, and 2) Different species at different scales with similar functions and different sensitivities to disturbance. This “within-scale and between-scale diversity produces an overlapping reinforcement of function that is remarkably robust” and which the authors call ’imbricated redundancy’. System resilience (the ability of an ecosystem to re-establish itself after disturbance) critically relies on this redundancy and it is a serious error to assume that minor or redundant species can afford to be lost, because their importance may only be detected when they are needed, i.e. following a disruption.

If we regard these two types of diversity and their effects on system resilience as organising principles, we find surprisingly similar effects in social systems. Similar to the idea of ’imbricated redundancy’ of species within and across scales is the idea of institutional diversity and multi-level governance for biodiversity conservation (Gatzweiler 2005a), or ’a hierarchy of cascaded institutions’ (Martin 2003). Apart from the creation of a ’scattering of strong local jurisdictions’ and the promotion of the economic value of biodiversity resources this institutional structure is required to match jurisdictional imperatives; and Martin (2003) argues that it is a condition for effective, stable, and equitable conservation at the national level. Ostrom (1998) argues along the same lines that in order to govern complexity in ecosystems appropriately, the respective nested and multi-layered institutions will be complex because of the ‘Law of Requisite Variety’. This law which was developed by Ashby (1960), a psychiatrist and one of the founding fathers of cybernetics, states that any regulative system needs as much variety in the actions that it can take as exists in the system it is regulating.

Elinor Ostrom and Roger Parks (in McGinnis 1999: 284) study mixed systems of metropolitan organization and conclude: “the more social scientists preach the need for simple solutions to complex problems, the more harm we can potentially cause in the world.” This warning refers to the same type of mistake pointed to by Gunderson and Holling (2002: 408) who warn that seemingly redundant species can not be afforded to be lost. Despite this warning, one widely held argument is, especially among economists, that whatever way we choose to conserve biodiversity, it should be done efficiently; the criterion being defined with the below mentioned narrow understanding of individual rationality. Similarly, in the context of public service reform, individuals had argued on the ground of efficiency that many local jurisdictions should be merged into a single unit of government. Ostrom et al. (1961: 53) challenge that presumption by stating that the consolidation argument need not hold “if agencies offer similar but differentiated services that impinge upon diverse communities of interest.” Advocates of polycentric governance argue that polycentric systems, “because of their nested and overlapping structures, can be sized to respond to the preferences of publics that may vary enormously in scope” (Bikers and Williams 2001: 94).

Low et al. (2003: 83) investigate the role of redundancy in genetic, ecological, and governance systems and define functionally different kinds of redundancy, which are very similar to those types described by Gunderson and Holling (2002). They also distinguish intra-level (within one level) and inter-level (across multiple levels) redundancy and suggest conditions which make redundancy advantageous or efficient. However, depending on the conditions and dynamics of the system, redundant systems can be con- or destructive. Their final message is that prescriptive approaches are not useful and that “it is crucial to analyze the level of diversity, types of risk, and location of important information in diverse locations before making any judgement about the impact of specific kinds of redundancy in a governing system” (Low et al. 2003).

Despite the absence of simple solutions for governing complexity in ecological and social systems there are principles and lessons learnt. The first principle refers to context specificity. Because of the great variability in the attributes of actors and features and functions of ecosystems there are no organisational ’quick fixes’. This has been repeatedly confirmed, for example in a recent ’Comprehensive Assessment of Water Management in Agriculture’ by the International Water Management Institute or in the works of the International Forest Resources and Institutions Network. The other principles also build on lessons learnt in water management (Ostrom 1992) but also in forest management (Gibson et al. 2000). The following enabling conditions are supportive for successful governance of biodiversity: 1) User groups need the right to organize and to set and change the rules, 2) the boundaries of the resource must be clear, 3) criteria for group membership must be clear, 4) use rules should be environmentally conservative and need to be easily enforceable, 5) infractions must be monitored and sanctioned, 6) decision-making rules need to be viewed as being fair, and 7) conflict resolution methods need to be available.

3 From Individual to Social and Communicative Rationality

The individual rationality of the ‘efficiency stance’ says that rational behaviour exists when a person’s choice is one that is the best for himself. Choices are ruled by the rationality of maximizing one’s own utility or well-being. This ’rational egoist’ (Ostrom 2004: 94) lives in an environment with stable, competitive conditions where people are completely informed, are able to attach values to a range of possible actions, and, after a complete analysis of all involved costs and benefits, will choose an action which maximizes his own net benefits. But as Gode and Sunder (1997) show, it is the set of rules constituting a market which leads to efficient choices and not necessarily the individual’s calculative behaviour. That is an indication that the institutional arrangements within which people act and make choices, rather than human behaviour itself is the root cause of biodiversity loss. Institutions define the logic or rationality of a specific choice (Vatn 2005).

Let us look at the ‘rational egoist’ who needs to attach values to biodiversity components in order to make a choice of whether to conserve them or not. For him, conservation of biodiversity is a means to achieve increased levels of well-being. The values considered cover a wide range from use to non-use values. In his institutional setting the rational egoist is not allowed to waste scarce resources, so he needs to make a choice based on the net benefits he is likely to derive from his choice of action. In addition, he will discount the expected benefits because using them now is more worth to him than using them tomorrow, especially when facing risk. Next, in the process of making a decision, our ‘rational egoist’ is endowed with super-human abilities: he is able to foresee and take all contingencies into account and calculate the optimal course of action. He can do that in an instant and at no cost. Further, the assumption of the economic efficiency stance is, that if we aggregate the preferences of the individual, we will know about the preferences of society: the social entity is the sum of its individual parts.

This mode of making choices is one that constantly weighs costs and benefits and is in permanent search of optimality and efficiency. It is deeply rooted 1) in the way we define people (e.g., ’homo oeconomicus’ or ’homo politicus’), 2) what we take into account as data, and 3) which data processing tools we use. Vatn (2005) defines ’value articulating institutions' (VAI) by these three components.[3] In our attempt to value biodiversity we are free to choose the type of VAI which we think ought to be applied. That is a normative problem. It is not a positive question because there is not a clear, full, and commonly held set of values on the basis of which the question could be answered.

Which VAI to choose depends on the following core questions (Vatn 2005):

- Is the issue or good individual or common?
- What is the degree of complexity?
- Is the issue or good characterized by one or plural value dimensions? Are preferences given or may they change?
- What is a logical aggregation procedure given answers to the above? E.g., the whole is equal to or greater than the sum of its parts.

Also among institutional economists efficiency has been an issue. The transaction cost approach has been used to identify those governance structures that are more efficient than others. For example, Birner and Wittmer (2000) use this approach to develop efficiency oriented institutions for sustainable resource management. They approach the questions of how the efficient level of decentralisation and devolution can be determined, and how the comparative efficiency of different forms of governance involving public and private sector institutions at different levels can be assessed. One of the major hypotheses of transaction cost economics is that the performance of an organizational form depends on its alignment with the characteristics of respective transactions (Williamson and Masten 1999). Birner and Wittmer (2000), however, also note that transaction cost economics has limitations “in situations where the empirically observed governance structures […] have to be considered as outcomes of power-oriented political processes rather than of efficiency-oriented institutional choice.” Another limitation of this approach is the fact that costs accrue for transactions between people. The costs of transactions between people and the ecosystem, however, are more difficult to assess and brings us back to the problem of externalities.

As suggested by Gatzweiler (2005a), biodiversity conservation is a complex task which requires collective action. For collective action to work the rationality of human actors trying to achieve the task of biodiversity conservation needs to shift from an individual to a social

[3] Or, the normative and epistemological predispositions of every method.

type. In biodiversity conservation people need to communicate about ‘second order problems’, meaning, they need to come to an understanding of what should be achieved and how, and they need to come to such an understanding together. Habermas (1984) termed this kind of reasoning ’communicative rationality’: communication about what should be achieved together. Or, as Vatn (2005: 125) puts it: “It is about reasoning together about which solution should be sought for the collective sharing of the common good. It is about developing, criticizing and testing arguments concerning which norms or behavioral rules should be supported. […] It is the argument that is the core of social rationality.” Along the same lines, Etzioni (1988) distinguishes between behaviour motivated by individual utility (the ‘I’) and behaviour motivated by norms and moral reasoning (the ‘We’) about what is the right thing to do.

In contrast to social choices made on the basis of calculating the sum of individual choices (individual rationality), like it is done in the ‘efficiency stance’, social rationality involves reasoned choices made by all stakeholders involved and decisions based on processes of deliberation. Some of the most ambitious decisions, like that of whether to conserve biodiversity or not and how, need to be taken across ethical and cultural boundaries – a reason to move from individual to social rationality, or, as Herbert Simon contrasts ‘rational’ and ‘social’ models of man (Simon 1957). Socially rational agents adapt their behaviour in response to social environments and, obviously, ethical codes of behaviour play an important role. Social rationality is not based on an independent verification of facts (such as values revealed in the willingness-to-pay approach) but (also) on values which evolve as norms and belief systems in the process of deliberative decision-making.

4 From Instrumental and Intrinsic Values to Feelings

The concept of ’total economic value’ is well known and it comprises direct use, indirect use, and non-use values. All the values listed under those categories are instrumental: something is valued because it serves another end. Thereby, economic values perfectly fit into the logic of efficiency and to the logic of Baxter (1974) that conservation is not an end in itself but a means to a higher end. Sometimes existence value is portrayed as intrinsic value; but it is not, because if the knowledge of the existence of some part of biodiversity makes people happy, this value contributes to changing their well-being. So that value can be seen as a means to the end of happiness or well-being.

Intrinsic value is the value of something; even if it is good for nothing. It is the value of something for its own sake or in itself. An end in itself carries intrinsic value. Callicot (1985:

275) provides two proofs of the existence of intrinsic value: the phenomenological and the teleological proof. Former refers back to humans themselves and the belief or norm which says that human dignity and ethical entitlement is a right in itself and, therefore, it is grounded in the claim to possess intrinsic value. Latter argues that the existence of means implies the existence of ends. While means have instrumental value and can be linked in chains (A is useful for B which is useful for C and so on) they ultimately need to lead to an end in itself, which has intrinsic value. Callicot's (1985) logic on this is that if ends-in-themselves exist (they must if means do) then intrinsic value exists.

Determining whether intrinsic values exist or not refers to beliefs and moral statements. We think or believe people and nature should have intrinsic value and, therefore, they have. Just like things have instrumental value because they are valued instrumentally, they have intrinsic value because they are valued intrinsically. Therefore, the existence of intrinsic value is a 'moral truth', which is held by some but obviously not all.

The existence of intrinsic value introduces another level of institutional embeddedness in explaining people's behaviour: the institutional economics level at the embeddedness level of which Williamson (2000: 595) says it belongs to social theory and "remains in need of greater theoretical specification." Despite the economists' knowledge gaps on that level of economizing, Williamson (2000: 596) recognizes that institutions at that level:

- "change very slow,
- have spontaneous and evolutionary origins ("which is to say that deliberative choice of a calculative kind is minimally implicated"),
- are pervasively linked with complementary (informal and formal) institutions, and therefore
- have a lasting grip on the way a society conducts itself."

If the intrinsic value of nature would be widely legally institutionalized, logging companies, for example, would have a much more difficult time to provide justification for felling an old-growth forest, says Fox (1993: 10). He explains that this "is comparable to the difference (of a legal system) that operates on a presumption of guilt until innocence is proved beyond reasonable doubt and one that operates on a presumption of innocence until guilt is proved beyond reasonable doubt."

Another question is whether the institutional level of moral truths to which we have put intrinsic values are important in dealing with complexity. Whereas some norms may have evolved spontaneously, they appear as institutionalized prescriptions and can consciously be made use of in decision-making situations. But the governance of social life depends on yet another level of institutions: feelings and emotions.

Antonio Damasio (2003: 158) links feelings and emotions causally with ethical behaviour. He says that "…it appears that the compromise of emotion and feeling in early human development would not have boded well for the emergence of ethical behavior. …If social emotions and feelings are not properly employed…the individual cannot categorize the experience of events…according to the emotion/feeling that confers "goodness" or "badness" upon these experiences. That would preclude any subsequent level of construction of the notions of goodness and badness (…)." He defines feelings as "mental representations of parts of the body or of the whole body as operating in a certain manner" (ibid: 85, 177). It is the consciousness of the brain about certain body states, or neural maps of body states. These body state maps require consciousness (feeling) because without we could, e.g., only deal with limited complexity. When problems get too complicated and require a mixture of automated response (body state maps of the brain) and reasoning on accumulated knowledge "unconscious maps no longer help and feelings come in handy.". Feelings improve the process of managing life and enable the biological corrections necessary for survival by offering explicit and highlighted information. They label neural maps and thereby add information to mental processes.

Damasio characterizes feeling as the "embryo of ethical behavior" and part of "an overall program of bioregulation." (ibid: 162). Just like feelings are homeostatic devices to keep the body-brain system in balance, so are ethical and other institutions to keep social life in balance. And nature is an integral part of our (social) life. Damasio believes that ethical behaviour depends on the working of certain brain systems – systems which are not exclusively dedicated to ethics but also to biological regulation, memory, decision-making, and creativity. And on those grounds he ties the role of feelings to natural life-monitoring functions: "Ever since feelings began, their natural role would have been to keep the condition of life in mind and to make the condition of life count in the organization of behavior. (…) Our life must be regulated not only by our own desires and feelings but also by our concern for the desires and feelings of others expressed as social conventions and rules of ethical behavior."

Damasio further says that "…feelings remain essential to maintaining those goals the cultural group considers unavoidable and worthy of perfecting. Feelings also are a necessary guide to the invention and negotiation of ways and means that somehow, will not clash with basic life regulation and distort the intention behind the goal. Feelings remain as important today as when humans first discovered that killing other humans was a questionable action.".

To resume, in this section we have shown that apart from instrumental values, which are mainly dealt with in economics, people also attach intrinsic values to biodiversity. Intrinsic values are moral truths but they are neglected in economics and therefore left aside in economic valuation. The negligence of intrinsic values leads to the view that biodiversity conservation is a means to a ‘higher end’ and not an end in itself. Further, we have argued that intrinsic values belong to the realm of ethical behaviour which depends on the functioning of certain brain systems from which feelings evolve. Feelings are homeostatic devices which help govern lives and are important for survival. They are also important in decision-making situations where the degree of complexity is overwhelming so that the brain’s automated responses require this additional information which comes in form of feelings.

5 Value Articulating Institutions

A strong argument for conserving biodiversity is that it is of value to humans and therefore humans actually value biodiversity for something. That is why economists are usually called to calculate its ’total economic value’. What is often overlooked in doing so, is that assessing and articulating values also includes the choice of the ’value articulating institution’, i.e., the method of valuation. Defining valuation methods as value articulating institutions makes clear that people define the rules for how they value and thereby of course also strongly influence the outcome of the valuation. People define the rules of the game they play with nature themselves. Before calculating the values of biodiversity the ‘second order problem’ needs to be answered: whose values count and how shall they be calculated? These questions refer to the assumptions made related to the capacity of people to clarify the issues involved and to do the necessary evaluations and computation as well as how to aggregate individual preferences or priorities (Vatn 2005: 331). The choice of a ‘value articulating institution’, or a method to value biodiversity, needs to be made based on the type of goods to be valued and the degree of systems’ complexity. The type of rationality is then defined by that institution. For example, if we choose to apply the willingness-to-pay and Cost-Benefit Analysis method, the rationality is that of the ‘rational egoist’ and the type of ecological goods and services are restricted to those we know of being useful.

Cost-Benefit Analysis is based on a mathematical and instrumental logic. Making a choice whether investments into a biodiversity conservation project are worthwhile, or not, follows the cost-benefit rule, and calculating the economic values of the goods and services to be valued is based on the willingness of people to pay for it. It is assumed that those people have the same amount of information about the valued goods and actually think it is reasonable to express values in monetary terms. In contrast to this ‘efficiency stance’, deliberative methods (the ‘democracy stance’, see Table 1) are based on the role of arguments and potential preference changes which may follow from communication about what should be done. O’Connor (1998) describes the deliberative methods as the ‘democracy stance’. In contrast to the ’one dollar – one vote’-democracy of Cost-Benefit Analysis, it describes a process where people express their individual views freely and debate and discuss in a process of deliberation. Methods include citizen’s juries, discourse analysis, institutional analysis, stakeholder meetings and combinations of these methods. The ‘complexity stance’ combines methods from both stances and adds methods from multi-criteria analysis.

Recognizing the fact that valuation methods are ’value articulating institutions’ and that the choice of a method can strongly influence the outcome of a valuation exercise and thereby actual behaviour and actions taken, points to the argument that people are co-producers or ’co-creators‘ (Atlee 2003) of institutional change. Atlee argues that (global) environmental change is a collective process, the consequences of which we can not comprehend in its entire range, depth, and detail, as individuals. Therefore, better ways are needed to perceive and reflect on the state of the earth. He suggests that instead of summing up individual incomprehensions, collective intelligence is required, which is a coherent integration of the individual diversity of perceptions and values. Atlee defines co-intelligence as a human capacity and ability to generate creative responses.

In the face of biodiversity loss and other global threats, Ehrlich and Kennedy (2005) identify “collective actions of individuals” (see also Gatzweiler 2005a) as lying “at the heart of the dilemma” and suggest the establishment of a forum which enables the analysis of individual motives and values, which are critical to solving these global threats.

Table 1: The ’Efficiency Stance’ and the ’Democracy Stance’ in ‘Value Articulating Institutions’

Distinguishing features	**Efficiency stance**	**Democracy stance**
Human rationality and motivation	Utility maximizers with a given preference structure	People with mixed motives and indeterminate values
Engagement of subjects	Subjects are reactive, isolated and individual. Their views are private and not open to challenge. Subject is confined to one role	Subject is interactive group member; views are public and open to challenge; subject is free to try out different roles
Promulgation of the framing of issues	Questions are decided by the researcher	Questions evolve through negotiation between researchers and stakeholders, jurors.
Relation between subject and policy maker	Subject is customer; policy maker’s role is to satisfy and accommodate customer’s preferences; policy maker is invulnerable; relationship of mutual benefit	Subject is a citizen with whom the policy-maker shares responsibilities of decision-making; policy-maker is vulnerable; relationship of trust
Outcomes	Quantified, consistent outcomes about people’s concerns which can be used to validate policies or estimate likely compliance with a policy	Rarely quantified outcomes with unclear or inconsistent logic which reveals how people understand the issue
Information handling	Information is (largely) anonymous and unquestioned	Information is owned, defended and contradicted
Information and knowledge	Quantity of information provided	Quality of how information is construed
Methodology	…is sovereign; process is theory driven and circumscribed	…is fluid; process is creative, dynamic and open ended
Distributional issues	Condones existing distributions of rights; silences some voices (protest bids, income effects); open to manipulation by researcher	Can challenge existing distributions of rights; silences some voices; open to manipulation by participants (participation)
Validation	…through precedent, consistency with previous studies, convergence and methodological rigour	…through argument and mutual acknowledgement among participants/stakeholders
Institutions for assimilation of results	Digestible by bureaucratic and financial structures	Can be indigestible to traditional bureaucratic and financial structures; open to create new institutional structures
What’s the point?	Point of exercise is to come to an outcome within given institutional infrastructure	The point of the exercise is the outcome and the process as well as the active/innovative institutionalization of collective action
Significance	Fosters ‘customer’ habits and managerial society	Fosters civic habits/identity and democratic values

Source: O’ Connor (1998: 3)

In such a forum, a global discussion of key ethical issues, human cultures, their views and values related to environmental sustainability, and what kind of changes might enable a shift towards an ecologically sustainable, peaceful, and equitable global society, would be discussed. The authors argue that history has shown that collapses of past societies were rooted in maladaptive cultural tradition or "an unwillingness to count the clearly measurable costs of their actions" (see also Diamond 2005). They also point to the fact that the 'tragedy of the commons' is no one-way dilemma, as the works of Vincent and Elinor Ostrom have proved to sufficient detail, and that the 'rational choice' paradigm as propagated by mainstream economists (Kahnemann et al. 1982) has been challenged. A global forum for discussion, debate, negotiation, and communication could facilitate the adaptation to global changes and not move towards the collapse of social and ecological systems (Ehrlich and Kennedy 2005).

To summarize our arguments in the previous sections: the more complexity is taken into account in biodiversity conservation (and probably in any complex decision-making situation), the less relevant is efficiency as a principle for decision-making. The relevance of economic efficiency as principle for biodiversity conservation decreases with the number of different types of goods and services (from private to common pool to public), the different types of values considered (from instrumental to intrinsic), and the type of rationality applied (from individual to social) (Figure 2).

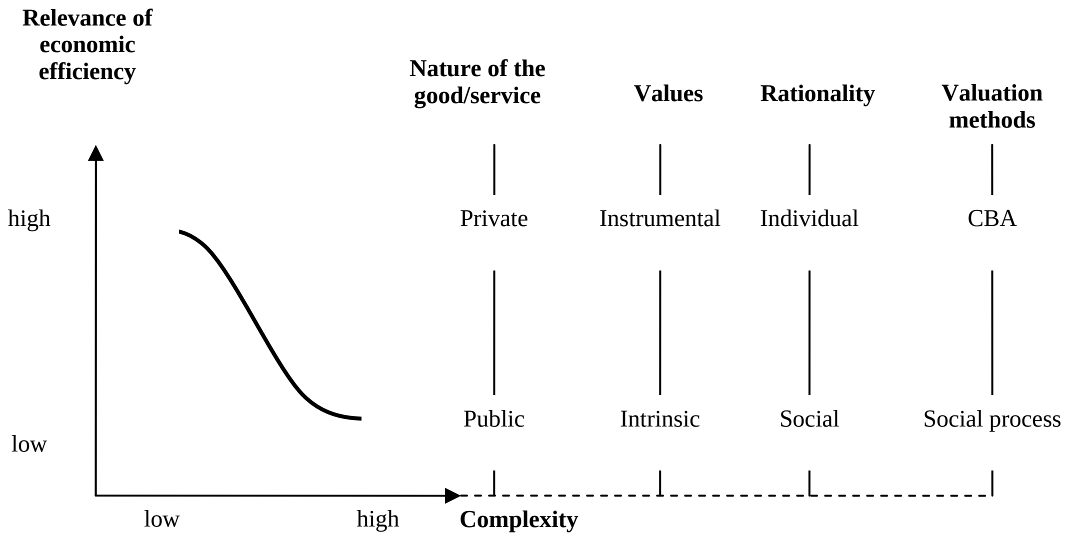

Figure 2: Increasing Complexity and Decreasing Relevance of Decisions Based on Economic Efficiency

6 Coping with Complexity for the Conservation of Wild Coffee Forest in Ethiopia

The following case study wants to demonstrate how stakeholders deal with the complexities of conserving and sustainably using coffee forest diversity in Ethiopia. Wild *Coffea arabica* grows in the Afromontane rainforests of Ethiopia and it is threatened to extinction because its habitat, the rainforests, is being depleted. The case study introduces a method which allows involved stakeholders to understand the socio-ecological system which they are dealing with and its dynamics in a deliberative process informed by scientific facts on the ecological characteristics and species diversity of the forests and the economic values of the coffee forests, as well as of the wild populations as a genetic resource for breeding (Rojahn 2006; Hein and Gatzweiler 2006). The group of stakeholders participating in the process needs to discuss and come to a consensus on each of the relationships among the variables which define the system and, in an ideal situation (which was not given in this case), local community members participate and the group can take decisions on actions which help to achieve their defined goals.

A series of workshops carried out by the Ethiopian Coffee Forest Forum (ECFF), the Amber Foundation, and the Center for Development Research (ZEF Bonn) under the title of "Putting complexity in perspective – Development of coffee forest conservation strategies" in 2005 brought together Ethiopian policy makers, NGOs, and scientists to model the complexities of a system which was called *'coffee forest conservation in Ethiopia'*. The objective was stated in the expression of the following vision: "Acknowledging the past importance of coffee forests and their current threats, they shall be conserved in a manner which improves local livelihoods, ensures income generation, and sustains forest ecology/biodiversity. This should be achieved for present and future generations by the participation of local communities." (CoCE 2005). The first challenge towards achieving this objective was to cope with the diversity of actors in the same field, stepping on each others toes or not knowing of the activities of each other. The coffee forests can be described as an experimental field for testing which governance approach to forest management works.

The strict exclusionary command-and-control approach is applied in three forest areas which are less densely populated (Geba-Dogi near Metu in Yayu district, Boginda Yeba near Bonga in Kaffa Zone, and Kontir-Berhan near Mizan Teferi in Sheko district). The co-management approach is tested through the help of foreign NGOs by implementing Participatory Forest Management (PFM) projects in more densely populated areas: Belete Gera, Bonga, and Bale. Despite local success stories, PFM projects in Ethiopia are better described as *state-prescribed* projects facilitated by *state-approved* NGOs (of which 2/3 are not Ethiopian and all are state-influenced) in which communities are told how to participate and where new institutions are built often neglecting traditional structures. Here, PFM can be described as being socially engineered. How sustainable community forest management can be achieved beyond the strict control of the project scale in all forest areas and without the massive external inputs of foreign NGOs is still an open question (ECFF 2005). Local community governance is also practiced. But it is not practiced as a deliberative process of a civil society. Self governance of forest resources is rather a necessity which has evolved from local power structures and legacies of the socialist past mixed with ethnic and cultural traditions, and which is driven by the immediate need to achieve food security. Self governance has evolved from a status of tolerated illegality (Stellmacher 2005) and from the certainty that state support is unreliable or absent.

Further steps taken to cope with the challenge of complexity were to understand the components and relationships within the respective system. This was done by the support of the Sensitivity Analysis developed by Frederic Vester (2002: 185; see also Volkmann et al. 2005; AMBER 2005). The analysis is based on the concepts of system dynamics and fuzzy logic. It facilitates the modelling of the system's complexity in a participatory manner and, if done properly, can give the right impulse or incentives for systems to regulate themselves (Vester 2002: 154). Different policies can be simulated and the sensitivity of system components (variables) can be tested. The Sensitivity Analysis also allows to evaluate the resilience of a modelled system and to identify the criteria which (de)stabilize the system. In contrast to reductionistic approaches which start with assumptions of a well-defined and reduced version of reality, this approach starts with initial complexity and reduces it in the course of the exercise to fewer but key relationships within a system.

In a three-day workshop with Ethiopian stakeholders, 24 variables were selected to describe the system 'coffee forest conservation'. Each of the variables was defined to ensure that the participants of the exercise had the same understanding of their meaning. Based on expert knowledge and research findings the actual and/or potential influence of each variable on one another was defined in a so-called 'cross impact matrix' (Figure 3). The 'cross impact matrix' shows which marginal effect a change of variable A has on variable B. Thereby '0' stands for no effect, '1' means weak under-proportional effect, '2' means proportional effect, and '3' means a change of 1 in variable A causes an over-proportional change in variable B. All the effects were discussed and evaluated in the group.

	Influence by ↓ to →	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	AS	P
1	Governance	X	2	2	2	1	2	1	2	2	2	2	2	2	2	0	2	1	1	0	2	2	2	2	2	38	608
2	Policy Implementation	1	X	1	1	2	2	1	2	2	2	2	1	2	2	1	2	1	1	0	2	2	2	2	1	35	1015
3	Policies	2	2	X	1	2	2	1	2	2	2	2	1	2	2	1	2	2	1	1	2	2	2	2	2	40	1360
4	Community Participation	1	2	1	X	2	2	3	3	3	1	3	2	2	2	2	0	1	1	2	1	2	2	2	2	42	1764
5	Population Dynamics	1	2	2	1	X	2	1	1	2	2	2	2	1	1	0	2	2	1	1	2	1	1	2	3	35	945
6	Benefit Sharing	0	1	1	2	0	X	0	2	1	2	2	2	2	2	2	2	2	3	1	2	2	2	2	2	37	1591
7	Culture	2	1	2	2	2	2	X	2	1	2	2	2	1	1	0	1	1	1	1	2	1	2	2	2	35	700
8	Gender Senitivity	1	2	2	2	2	2	1	X	2	2	2	2	2	2	0	1	1	1	1	1	2	2	2	2	37	1147
9	Infrastructure	2	2	2	2	3	2	2	2	X	3	3	2	3	3	2	3	2	3	2	2	3	2	2	2	54	2106
10	Access & Use Rights to Res.	1	2	2	3	1	2	0	2	1	X	3	2	2	1	1	2	2	1	1	2	2	2	2	2	39	1443
11	Livelihood	1	1	2	2	3	3	2	3	2	1	X	2	2	2	1	2	2	2	1	2	2	2	2	2	44	2244
12	Income Diversification	1	0	2	2	2	2	1	1	2	1	2	X	2	2	2	2	2	2	1	2	2	2	2	2	39	1716
13	Agric. Landuse Practices	1	1	2	2	1	2	1	1	1	1	2	2	X	2	1	2	2	1	2	2	2	2	2	3	38	1596
14	Capacity Building	2	2	1	2	1	2	1	2	3	2	3	1	2	X	1	2	2	3	2	2	2	2	2	2	44	1760
15	National/Int. Markets for NTFP	0	1	1	1	0	1	0	0	1	1	2	2	2	2	X	2	2	2	1	1	2	2	2	2	30	930
16	Local Markets	0	1	1	2	0	2	0	0	2	1	2	2	2	2	2	X	2	2	1	0	2	1	2	2	31	1302
17	Marketing Forest Coffee & NTFP	0	1	1	2	0	2	0	0	2	1	2	2	1	2	2	1	X	2	1	1	1	2	2	2	30	1230
18	Product Quality	0	0	1	2	0	2	0	0	2	1	2	2	2	2	2	2	2	X	1	1	1	2	2	1	30	1200
19	Pests and Diseases	0	0	1	1	0	0	0	0	0	0	2	1	1	1	2	2	2	3	X	1	2	2	2	2	25	775
20	Ecological Services	0	1	1	2	0	1	0	1	1	2	2	2	1	1	1	2	2	1	3	X	2	2	2	2	32	1280
21	Extension Services	0	2	1	2	1	2	1	2	2	2	2	2	2	2	2	2	2	2	2	2	X	2	2	2	41	1640
22	Biodiversity	0	0	2	2	1	3	1	1	2	2	2	3	2	1	2	2	2	2	2	3	1	X	2	2	40	1800
23	Forest & Coffee Forest Manag.	0	1	1	2	1	2	1	1	2	2	2	3	2	2	2	2	2	2	2	3	1	3	X	2	41	1927
24	Deforest. & envir. degradation	0	2	2	2	2	1	2	1	1	2	3	2	2	1	2	2	2	2	2	2	1	2	3	X	41	1886
	PS	16	29	34	42	27	43	20	31	39	37	51	44	42	40	31	42	41	40	31	40	40	45	47	46		
	Qx100	238	121	118	100	130	86	175	119	138	105	86	89	90	110	97	74	73	75	81	80	102	89	87	89		

Figure 3: Cross Impact Matrix

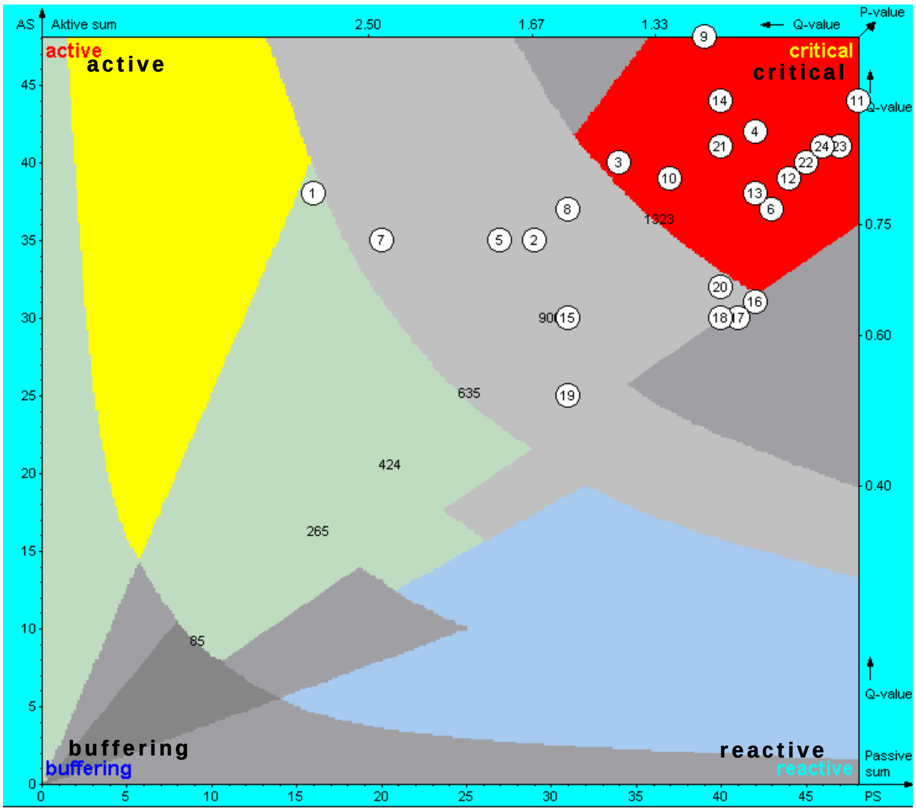

Figure 4: Systemic Role of System Variables and System Condition

After creating the 'cross impact matrix' it is possible to visualise the position of each variable in a three-dimensional space (Figure 4) showing the systemic role of each system variable. From the 'cross impact matrix' it is possible to calculate active (AS) and passive values (PS). Active values are the sum of effects of one variable on others and show how strong one variable affects all other system variables. Passive values are the sum of effects of all other variables on a specific variable and shows how strong the variable is affected. The active/passive ratio (Q-value) says whether a variable has an active or reactive character. Finally, the P-value (= AS x PS) expresses to which extent a system variable is connected into the system and with the other variables. The higher the P-value is, the more critical it is, because a change of that variable would cause changes of many other system variables as well. And this can destabilize the system. If the P-value of a system variable is low it contributes to the buffering capacity of the entire system.

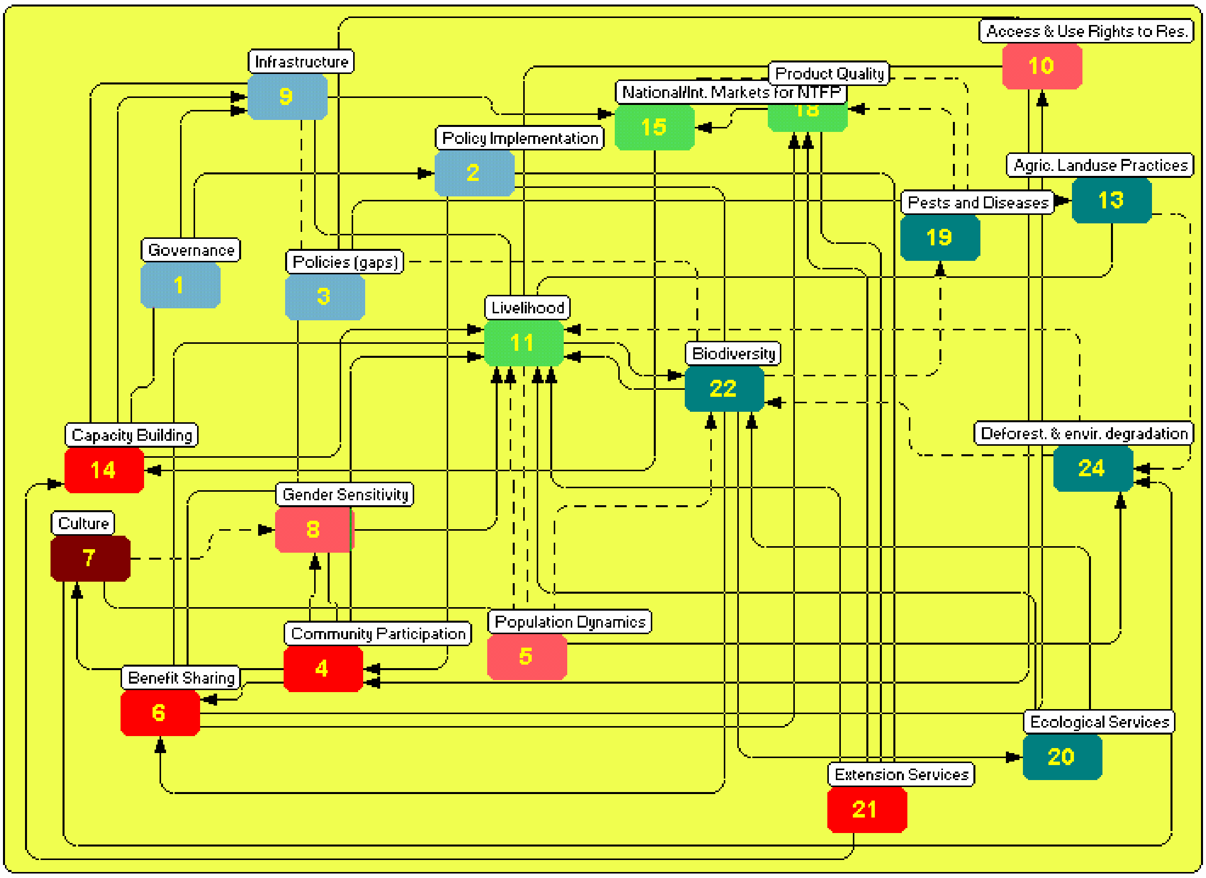

Figure 5: The Effect System

Figure 5 shows different components of the system 'coffee forest conservation' and their relationships. The representation of the actually observed relationships in the effect system, shows, that there are 51 negative feedback loops and 67 positive feedback loops. A positive feedback loop is one with each two of the same kind, either opposing or confirming feedbacks between two variables. A negative feedback loop is one with two different relations (one opposing and one confirming) between two variables. As there are more positive feedbacks, the system is unstable and will eventually run out of control. In Figure 3 the drawn through arrows represent confirming relations (’if A increases, B increases’ or ’if A decreases, B decreases’) whereas the dashed arrows represent opposing relations (’if A increases, B decreases’ or ‘if A decreases, B increases’).

The outcomes of the Vester Sensitivity modelling exercise leads to two important insights: 1) the enabling environment, consisting of several variables, such as ’governance’ and ’policy implementation’, is an important issue to deal with in governing complex systems, and 2) the process of defining a common vision and collectively working together in designing the model is in itself an important step towards governing complexity. This process-oriented method was viewed as being more important than target-oriented and efficiency-led methods because the target needs to be defined commonly in advance. Defining this target is not easy if biodiversity is not merely a means to another (higher) end which needs to be achieved efficiently, but also an end in itself. The Vester Sensitivity modelling approach provided understanding of the systemic and complex character of a task such as ’coffee forest conservation’. It does not merely aim at revealing views and values of the participants but it allows for changes of views and values by communicative and deliberative processes.

7 Conclusions

’Beyond economic efficiency’ does not imply the exclusion of the efficiency principle in decision-making, nor does it imply that inefficient ways are required to achieve biodiversity conservation. Rather it points to the need to create new values in the process towards that goal. Making a choice of whether to conserve biodiversity, or not, and if, how much, can only partly be guided by decision-support based on the principle of economic efficiency, as for example Cost-Benefit Analysis (CBA) does. The more complex the related systems become the less relevant are economic efficiency based decisions (Figure 2). We have argued:

1) Biodiversity is not just a resource but also an environmental condition or state which is the source of biological resources.

2) In contrast to choices made on the basis of individual rationality, social rationality involves reasoned choices made by all stakeholders involved and decisions based on processes of deliberation. Deciding on how to decide with regards to the problem of

biodiversity loss is not a positive question because there is not a clear, full, and commonly held set of values on the basis of which the question could be answered.

3) Apart from instrumental values, which are mainly dealt with in economics, people also attach intrinsic values to biodiversity. Intrinsic values are moral truths, but they are left aside in economic valuation. The negligence of intrinsic values leads to the view that biodiversity conservation is merely a means to a 'higher end' and not an end in itself. It is both. Merely deciding on the basis of values we consider as pre-existing and able to reveal will help to explain biodiversity loss but not halt it.

4) Intrinsic values are moral truths. For achieving the goal of biodiversity conservation, we need to understand better how they influence behaviour and it is necessary to reconstruct and adapt the values and ethics on the basis of which humans behave to respond better to global environmental change. We therefore support the suggestion of Ehrlich and Kennedy (2005) to initiate a worldwide process of discussing and better understanding key ethical issues. This also provokes the question in how far biodiversity conservation can be achieved in regimes where basic democratic rights and freedoms, such as freedom of speech and association are regulated by the state or not practiced by the people and where participation is absent or state-prescribed and controlled.

5) Intrinsic values belong to the realm of ethical behaviour which depends on the functioning of certain brain systems from which feelings evolve. Feelings are homeostatic devices which help govern lives and are important for survival. They are also important in decision-making situations where the degree of complexity is overwhelming so that the brain's automated responses require this additional information which comes in form of feelings. Both intrinsic values and feeling have been largely neglected in decision-support despite their pervasive influence and persistence on other institutions shaping human behaviour. Social processes in valuing biodiversity do not neglect them.

6) Because biodiversity is not merely an assemblage of biological resources but also an environmental condition which is the precondition for biological resources, economic valuation and subsequent Cost-Benefit Analyses can help only partly in coping with the governance of complexity in biodiversity conservation. However, economic values, once known, can initiate a social process of awareness building. In that process new values are created. That is different from presenting the results of a valuation study to decision-makers who are then supposed to make rational decisions.

7) In contrast to Cost-Benefit Analysis which can be regarded as an example for an ‘efficiency stance’ guided decision-support tool, we have demonstrated an alternative method which can cope with the different aspects of biodiversity and its complex nature. Experiences with modelling complex systems, such as the Ethiopian coffee forests by means of the Vester Sensitivity Analysis show 1) apart from precise knowledge of relationships between single components it is crucial for understanding complexity to understand relationships between those components which make it a system and which keep it resilient, and 2) that the results are less important than the process of modelling, communicating, and achieving incremental advances in understanding the respective system’s complexity. Each time the modelling exercise was carried out it led to different system behaviours. The expectation that sophisticated computer supported modelling can deliver the answers as to which variables need to be ’fixed’ to improve the system’s functioning, is an illusion and belongs to that kind of social engineering thinking which is insufficient for dealing with the governance of complexity in biodiversity conservation.

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